A REVIEW PAPER ON REPLACEMENT OF CEMENT WITH SUGARCANE BAGASSE ASH

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Abstract- The present study focuses on the utilization of Sugarcane Bagasse Ash as replacement material for cement in concrete production.Demand and consumption of cement is increasing day by day which has led researchers and scientists to search for locally available alternate binders that can replace cement partially and are ecofriendly and contribute towards waste management. In this direction the industrial & agricultural waste play vital role.Sugarcane Bagasse ash contains high amorphous silica content and aluminum.

The agricultural waste product like Sugar Cane Bagasse Ash (SBCA) is used as alternate binding material in the present study. This will result in saving in cement production equivalent to the alternative binding material used in concrete. The bagasse ash used for the research work is obtained from M/sK M Sugar MillPvt.Ltd.Kanpur which is grinded and sieved through sieve of size 150 micron and passing out fraction is used in concrete as a partial replacement of cement in the ratio of 2% 4%, 6%, 8% & 10%by weight of the cement.Ordinary Portland Cement 43 grade cement is used in the study. The effect of replacement of cement by bagasse ash on properties like workability for fresh concrete are tested and for hardened concrete compressive strength at the age of 7 days and 28 days are determined.

Keywords- *Bagasse Ash, Cement, Workability, Flexural & Compressive Strength.*

I.Introduction

Initiatives are developing worldwide to control andregulate the supervision of sub-products, residuals and industrial wastes in order to preserve the environment from contamination. A good solution to the problem of recycling agro industrial excess would be by burning them in a controlled environment and use the ashes (waste) for more polite means.
Utilization of such wastes as cement and fine aggregate replacement materials may reduce the cost of concrete production and also minimize the harmful environmental effects with disposal of these wastes.
Sugarcane is one of the foremost crops grown in all over countries and its entire production is over 1500 million tons. After the extraction of all efficient sugar from sugarcane, large fibrous excess is obtained.When bagasse is burnt in the boiler of cogenerationplant under controlled conditions, sensitive amorphous silica is formed due to the combustion process and is present in the remaining ashes known as Sugarcane Bagasse Ash. This amorphous silicacontent makes bagasse ash as a useful cementreplacement material in concrete. Each tons of sugarcane produces around 25.65% of bagasse (at a moisture content of 50%) and 0.61% of residual ash the excess after combustion presents a chemical composition controls by silicon dioxide (Sio_2). From the past investigates it is found that the bagasse ash comprises of the properties of nature sand.
But these ashes are produced under unrestrained and non-uniform burning conditions with temperatures rising above 1000°c resulting in a manifestation of the matter.In this study the bagasse ash is planned to use as the partial replacement for cement and fine aggregate in-order to utilize the wastages and to protect the atmosphere from the hazards. Sugarcane bagasse ash is normally used as manure in sugarcane plantation.
This paper investigates the impact of SCBA in concrete by partially replacing SCBA with cement in the ratio of 0%, 2%, 4%, 6%, 8% and 10% by weight for M20 grade of concrete. The experimental study examines the slump of the fresh concrete, compaction factor, compressive strength, split tensile strength, flexural strength, and modulus of elasticity.

NEED AND ADVANTAGES

Need of sugarcane bagasse ash (SCBA) usage:

1. Each ton of cement produces around about one ton of $CO_2$and cement industry is answerable for the release of about 5% of CO_2 worldwide.
2. Has an effective impact in the economical point of view.
3. When used as replacement for cement in concrete, it reduces the problem associated with their clearance.

4. Decrease in the release of greenhouse gases.

Advantages of sugarcane bagasse ash:

Land pollution

Predominantly the ash disposal problem from sugar industry is reduced since it is usually disposed offinopen land area.

Economy

Due to the non-availability of fine aggregate, theworth of natural sand which is used as fine aggregate has increased by three wrinkles in the past few months. Hence the overall price involved in the construction is reduced.

Future demand

Partial replacement will also help in meeting the increasing demand for fine aggregate in future.

SCOPE OF WORK

Laboratory tests on cement, fine aggregate, coarse aggregate, bagasse ash, water. Whatever may be the type of concrete being used, it is important to mix design of the concrete. The same is the case with the industrial waste based concrete or bagasse ash replacement. The major work involved is getting the appropriate mix proportions. In the present work, the concrete mixes with partial replacement of cement with bagasse ash were developed using OPC 43 grade cement. A simple mix design procedure is adopted to arrive at the mix proportions. After getting some trail mix, cubes of dimensions 150mm x 150mm x 150 mm was casted and cured in the curing tank. Compressive strength, Split tensile strength and Flexural strength of concrete were conducted to know the strength properties of the mixes. Initially, a sample mix design was followed and modifications were made accordingly while arriving at the trail mixes to get optimized mix which satisfies both fresh, hardened properties and the economy[4]. Finally, a simple mix design is proposed.

II. Material Used

The materials used in the investigations are

Cement

The cement is used as a binding material. In this study, the cement used as OPC 43 grade cementavailable from ACC Cement Company and it conforming as per IS 12269-1987.

Fine Aggregate

Aggregates for the concrete were obtained from approved suppliers conforming to the specifications of IS 383 - 1970 and were chemically inactive(inert), spotless and robust. The fine aggregate was tested as per the limits which is specified in IS: 2386 (Part-3) :1963. In this study, fine aggregate having a fineness modulus of 2.46 which is carried out by using sieve analysis and it confirming to zone 2.

Coarse Aggregate

Coarse aggregates will be machine-crushed one of black trap or equivalent black tough stone and shall be stiff, robust, dense, durable, spotless or procured from quarries approved by the consultant. In this study, crushed aggregate of size 20 mm in angular shape is used and it conforming to IS 383.

Sugarcane Bagasse Ash

It comprises high volume of Sio_2. Therefore, it isclassified as a good pozzolanic material. SCBA can be used as add-on forcementitious material due to its pozzolanic property. Sugarcane bagasse ash was collected from Kanpur.

SCBA contains approximately 25% of hemicellulose, 25% of lignin and 50% of cellulose. Each tons of sugarcane generates approximately 26% of bagasse (at 50% moisture content) and 0.62% of residual ash. The residue after combustion gives a chemical composition dominated by silicon dioxide. The Specific gravity of SCBA was found to be 2.17. Chemical properties of SCBA are shown in Table-1.

Table – 1

Sno.	Component t	Mass%
1	Silica (SiO_2)	71
2	Alumina (Al_2O_3)	1.9
3	Ferric Oxide (Fe_2O_3)	7.8
4	Calcium Oxide (CaO)	3.4
5	Magnesium Oxide (MgO)	0.3
6	Potassium Oxide (K_2O)	8.2

7	Sodium Oxide (Na_2O)	3.4
8	Phosphorus Pentoxide (P_2O_5)	02
9	Manganese Oxide (MnO)	0.2

Water

Good potable wateravailable in the site is used for the construction purpose which conforming to the requirements of water for concreting and curing as per IS: 456-2000[17].

III. MIXING AND CASTING

The mix design was done as per IS 456:2000[18] .The fresh concrete was mixed using flow pan mixer of 150.00Kg capacity till uniform through consistency was achieved, prior to the mixing; the materials were spread in layers in the bottom of the pan, coarse aggregate first, followed by cement and finally the fine aggregate. The constituents of the mixes were mixed dry for 1.00 minute in order to homogenize the batched mix; subsequently water was added and mixed for a further 3.00 minutes. The concrete was cast into the moulds in three layers, and 36.00 blows were given to each layer, using 16. 00 mm diameter bar, to remove any entrapped air. For each mix the required numbers of cubes (total of 150.00 cubes) were casted. The moulds were covered by sacking for 24.00 hours at room temperature. The specimens were de-molded after at least 24.00 hrs. and poured into the curing tank. Before the molding of the samples specimens workability tests were done to observe the effect of Sugarcane Bagasse Ash on fresh concrete properties.

The workability tests adopted for this investigation were the Slump Cone test and Compacting Factor test. The process of selecting suitable ingredients of concrete such as cement, sand, aggregate, water and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is known as the concrete mix design. The proportioning of ingredients of concrete such as cement, sand, aggregate & water is governed by the required performance of concrete in two states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance. The compressive strength of hardened concrete which is generally considered to be an index of its other properties, depending upon many factors, for ex. Water Cement ratio quality and quantity of cement, water, aggregate, batching, placing, compaction and curing. The cost of concrete is made up of the cost of material, plant and labour. The variation in the cost of material arise from the fact that the cement is several times costly than the aggregates, thus the aim is to produce as lean a mix as possible. The actual cost of concrete is related to the cost of materials required for producing a minimum mean strength known as characteristic strength that is specified by the designer of the structure. This depends on the quality control measures, but there is no doubt that the quality control adds to the cost of concrete. On the workability of mix the cost of labor is depend.

IV.EXPERIMENTAL WORK

In this experimental work, a total of 36 numbers of concrete specimens were casted. The specimens considered in this study consisted of 36.00 numbers of 150.00 mm side cubes, The mix design of concrete was done according to Indian Standard (IS) guidelines 6.00-9.00 for M20 grade for the granite stone aggregates and the water cement ratio are 0.480. Based upon the quantities of ingredient of the mixes, the quantities of Sugarcane Bagasse Ash (SCBA) for 0%, 5%, 10%, 15%, 20% & 25% replacement by weight were estimated. The ingredients of concrete such as cement, sand, aggregate & water were thoroughly mixed in tilting or non-tilting mixer machine till uniform thoroughly consistency was achieved. Before casting, machine oil was smeared on the inner surfaces of the Cast Iron (CI) mould. Concrete was poured into the mould and compacted thoroughly using table vibrator or other types of vibrators. The top surface was finished with the help of a trowel. The specimens were removed from the mould after 24.00 hrs. then cured under water for a period of 7 and 28 days. The specimens were taken out from the curing tank or water tank just prior to the test. The tests for compressive, split tensile strength were conducted using a2000.00 kN compression testing machine, the modulus of elasticity the test conducted using a compression testing machine and compressometer. For modulus of rupture was conducted using 1000.00 kN Universal Testing Machine (UTM). These tests were conducted as per the relevant Indian Standard (IS) specifications. In this experimental work, a total of 56.00 numbers of concrete specimens were casted. The standard size of cube 150.00 mm ×150.00 mm ×150.00 mm is used. The mix design of concrete was done according to Indian Standard (IS) guidelines for M20, M30 and M40 grade. Based upon the quantities of ingredient of the mixes, the quantities of Sugarcane Bagasse Ash (SCBA) for 0%, 10%, 15%, 20%, 25% and 30% replacement by weight were estimated. The ingredients of concrete such as cement, sand, aggregate & water were thoroughly mixed in tilting or non-tilting mixer machine till uniform thoroughly consistency was achieved. Before casting, machine oil was smeared on the inner surfaces of the Cast Iron (CI) mould. Concrete was immersed into the mould and compacted thoroughly using table vibrator & any other type of vibrator. The top surface was finished with the help of a trowel. The specimens were removed from the mould after 24.00 hrs. and then cured under water for a period of 7 and 28days. The specimens were taken out from the curing tank just prior to the test. The compressive test was conducted using a 2000.00 kN capacity compression testing machine. This test was conducted as per the relevant Indian Standard (IS) specifications.

V.Results

i.)Workability

A good-quality concrete should have acceptable workability in the fresh condition and should develop sufficient strength. The workability of the freshly mixed concrete was determined using slump cone test and compaction factor test.

ii.)Compressive Strength

Compressive strength of SCBA blended concrete cubes was determined after 28 days curing and tested as per IS 516:1959 [18]. The rate of loading of compressive strength testing machine is 0.5 tonnes/sec.

iii.)Split Tensile Strength

Cylinders of size 150mm in diameter and 300mm in length were cast and cured for 28 days. Each split tensile strength result is the average of three specimens. The test was conducted in acompression testing machine as per the Indian code IS 516:1959[18] and the maximum load applied on the specimen at the failure was recorded and the strength was calculated by using appropriate equation.

iv.)Flexural Strength:

Prism specimens that are cast and cured for 28 days were tested for maximum load. Flexural strength of concrete prism specimens containing various amount of bagasse ash was determined.

v.)Modulus of Elasticity:

Modulus of elasticity of cylinder specimens was determined using a compressometer. The Gauge length of compressometer is 200mm and least count of dial gauge is 0.002mm.

vi.)Compressive Development Strength:

This was due to the combined effect of relative fineness and the Pozzolonic activity of Sugarcane Baggage Ash (SCBA) and also may be due to the existing of crystalline silica (SiO2). According to Bui strengthening capability of a mineral admixture not only depends on the Pozzolonic reactivity, but also on the relative fineness of the filler material. At 90 day stage compressive strength for S4 10% replacement was shown clear developing strength about 0.960% of OPC while the other samples (S2 & S3) were shown 85% strength development than OPC. Decrease in compressive strength values with increase in the substitution ratio indicated that filler effect was predominant only up to 10% ash substitution. The increase in compressive strength values in the S4 is due to the combined effect of physical and chemical processes. Physical action was caused by the high specific surface area of Sugarcane Baggage Ash (SCBA) and chemical action was the Pozzolonic reaction between calcium hydroxide (CH) and silica (SiO2). Also the hydration of silica (SiO2) itself in the alkaline environment may have been responsible for increase in compressive strength. But hydration reaction in S2 and S3 specimen was slow; possible because of low reactivity of silica (SiO2) and also, the reduction in CaO contents may have caused the reduction in ultimate strength development.

VI.CONCLUSION

The experimental result shows that the strength of concrete is increase with the help of Sugar Cane Bagasse Ash (SCBA).Therefore, with the use of Sugarcane Baggage Ash (SCBA) in partially replacement of cement in concrete, we can increase the strength of concrete with reducing the consumption of cement. Also it is best use of Sugar Cane Bagasse Ash (SCBA) instead of land filling and make environment clean. This was due to the combined effect of relative fineness and the Pozzolonic activity of Sugarcane Bagasse Ash (SCBA) & also may be due to the existing of crystalline silica (SiO2). According to Bui strengthening capability of a mineral admixture not only depends on the Pozzolonic reactivity, but also on the relative fineness of the filler material. At 90.00 days stage compressive strength for S4 10% replacement was shown clear developing strength about 0.960% of Ordinary Portland Cement (OPC) while the other samples (S2 & S3) were shown 85% strength development than Ordinary Portland Cement (OPC). Decrease in compressive strength values with increase in the substitution ratio indicated that filler effect was predominant only up to 10% ash substitution. The increase in compressive strength values in the S4 is due to the combined effect of physical and chemical processes. Physical action was caused by the high specific surface area of Sugarcane Bagasse Ash (SCBA) & chemical action was the Pozzolonic reaction between calcium hydroxide (CH) and silica (SiO2). Also the hydration of silica (SiO2) itself in the alkaline environment may have been responsible for increase in compressive strength. But hydration reaction in S2 and S3 specimen was slow; possible because of low reactivity of silica (SiO2) and also, the reduction in CaO contents may have caused the reduction in ultimate strength development.

We conclude that the partial replacement of sugarcane bagasse ash with cement is successful and give the satisfactory result from experimental work.

Now we have to change fine aggregate (i.e stone dust and natural sand)instead of cement and see the experimental investigation on that.

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